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Grazing Towards Green Policy: Global Taxation Approaches to Methane Emissions

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Abstract

The agricultural sector is a significant contributor to global greenhouse gas (GHG) emissions, with methane (CH_4) from enteric fermentation and manure management posing substantial environmental challenges. Among the proposed regulatory mechanisms, agricultural emissions levies commonly referred to as 'methane taxes or fart taxes' have gained traction as a market-based solution to mitigate climate change. Methane (CH_4) is a potent greenhouse gas: over a 20-year horizon, one ton of CH_4 traps roughly 80–84 times more heat than CO_2. Livestock (ruminant) agriculture and rice paddies also contributes share of anthropogenic methane. Many countries, faced with ambitious climate goals, have debated "methane taxes" (levies on emissions from cows, sheep, rice, etc.) and other agricultural levies to encourage reductions. Such policies apply the polluter-pays principle to farming, either by charging producers for CH_4 emissions or by imposing levies on inputs (fertilizer, feed) tied to emissions. The aim is to curb emissions by raising costs (or funding research/incentives) in a sector that is otherwise hard to regulate. In this paper, the concept of methane taxation and related agricultural levies in the context of climate change is examined. In this study, the theory and public discourse surrounding environmental taxation instruments are examined, followed by a comparative look at how various jurisdictions have approached them. Special attention is given to New Zealand, the European Union particularly Denmark's innovative measures and the United States, where such policies have either been proposed or are already in place. Insights relevant to India are also explored. The analysis draws on academic research, government publications, and credible news sources to ensure a well-rounded, evidence-based perspective. By combining doctrinal and analytical methods, the paper seeks to contribute meaningfully to the broader conversation on the role of environmental taxes sometimes informally referred to as the "fart tax" in climate policy and sustainable agricultural governance.

Keywords

Methane taxation; Agricultural emissions levy; Fart tax; Greenhouse gas mitigation; Sustainable agri-environmental governance

Introduction

One of the most effective short-term strategies to limit global warming is to reduce methane emissions, which is also essential to preventing the worst effects of climate change. Approximately 40% of methane emissions worldwide that are generated by humans come from rice and cattle (Aksyutin *et al*., 2019). At the same time, millions of farmers rely on rice and cattle as their primary sources of income, making them essential food staples worldwide. Prioritizing methane reductions is an opportunity for the food and agriculture industries, whose supply networks depend on these commodities.

How long a greenhouse gas stays in the atmosphere and how well it absorbs energy are two important factors that affect how it affects the climate (Thaker and Leiserowitz, 2014). Compared to carbon dioxide (CO_2), methane has a significantly shorter atmospheric lifetime, roughly 12 years as opposed to centuries, but it absorbs a lot more energy during that period. These variables may be combined in a number of ways to calculate the impact on global warming and convert one ton of methane into CO_2-eq (CO_2 equivalent) (Key and Tallard, 2012). While several conversion factors can be used, the global warming potential is the most frequently referenced (Poterba, 1991). One ton of methane corresponds to 82 to 87 tons of CO_2, based on calculations of methane's impact over 20 years. Others examine its effects over 100 years, when one ton of methane is equal to around 30 tons of CO_2 (IEA, 2024). Methane emissions can be more directly linked to the anticipated rise in temperature in a future year using alternative measures, such as the Global Temperature Potential. In this study, one ton of methane is equivalent to thirty tons of CO_2 equivalent (CO_2-eq). Methane is an extremely potent greenhouse gas, and regardless of this conversion ratio, it is crucial for the energy industry to quickly and consistently reduce its emissions to keep global warming below 1.5°C. Because methane may produce the hazardous pollutant ground-level (tropospheric) ozone, it also has an impact on air quality (Harmsen *et al*., 2020). Leaks of methane can potentially cause health problems and explosions (Harper, 2007).

The importance of methane emissions and the need for accurate measurements to create practical strategies for mitigating climate change, such as increasing the use of renewable energy, have come to light more and more in recent years (FitzRoy and Papyrakis, 2016). In addition to methane emissions from the intestines, natural processes, agricultural practices, and waste management also contribute to methane formation. One of the main sources of methane emissions worldwide has been shown to be the livestock sector, namely the production of cows. Beef and dairy cattle are significant producers of methane due to enteric fermentation, which occurs in the rumen of ruminant animals during digestion (Wirsenius, Hedenus and Mohlin, 2011). In order to reach the “below 2°C target” by the end of the twenty-first century, 180 nations committed to further reducing greenhouse gas emissions at the 2015 United Nations (UN) climate summit in Paris (Marron, Toder and Austin, 2015). Global methane emissions were projected to reach 580 million tonnes (Mt), with around 60% coming from human activity and 40% coming from natural sources such as wetlands, according to the Global Methane Budget by Rodríguez-Garavito (2022). Agriculture accounted for around 145 Mt of methane emissions in 2017, the biggest contribution among human sources, while the energy industry came in second with roughly 130 Mt in 2023 (IEA, 2024). Oil activities supplied over 50 Mt to the energy sector, followed by the natural gas supply network with about

30 Mt and coal mining with another 40 Mt, mostly from underground mines (Tsai, 2020). Moreover, incomplete combustion of bioenergy, mostly from conventional biomass usage, accounted for 10 Mt (IEA, 2024). To mitigate methane emissions, targeted strategies such as detecting and repairing leaks in oil and gas infrastructure, enhancing methane capture technologies in coal mining, improving bioenergy combustion efficiency, and adopting sustainable agricultural practices are essential in addressing this potent greenhouse gas.

Methodology and Scope of Review

This paper is a narrative review synthesizing literature, policy reports, and credible news on agricultural methane pricing. Structured searches were conducted across academic databases (such as Web of Science, Scopus, and Google Scholar) as well as gray literature sources, including those from the IEA, FAO, CCAC, and official government websites, up to mid-2024. Keywords used included combinations such as “agriculture methane tax,” “enteric methane levy,” “fart tax,” “livestock emissions pricing,” “climate policy,” along with relevant country names (e.g., New Zealand, Denmark, the EU, the U.S., India). Priority was given to sources addressing methane pricing or regulatory approaches within the agricultural sector, while technical studies focused solely on energy-sector methane were excluded unless they provided transferable insights. The review encompassed policy analyses, simulation models, news coverage, and reports by NGOs.

The case studies were chosen for their relevance: New Zealand has debated farm CH_4 levies for decades (the “burp tax” or “fart tax”), providing empirical lessons; Denmark has just agreed a national livestock methane tax (2024) as part of its climate deal; the EU and its member states offer experience with agri-climate policies (though no unified methane tax yet); and the U.S. has large emissions and active policy debate (e.g. Washington State legislation) despite no federal farm tax. These high-income examples were chosen for their data availability and because their agricultural interests and emissions profiles are similar to those of India (e.g., populous farming sectors, significant political influence of agriculture.

Limitations

Being largely exploratory and comparative, this review is qualitative. The nascent state of methane-tax policy means few real-world outcomes to report; much relies on modeling or proposed plans. The paper focuses on OECD or high-emitting countries and this limits applicability to developing contexts. Our recommendations for India are therefore provisional, acknowledging uncertainties in how farmers might respond or how global cooperation might evolve.

Why were these case studies chosen?

New Zealand has been debating methane levies for farms, often referred to as the "burp tax" or "fart tax," for decades, providing valuable lessons in the process. Denmark has recently agreed to implement a national livestock methane tax in 2024 as part of its climate deal. The European Union and its member states offer experiences with agricultural climate policies, although there is currently no unified methane tax in place.

In the United States, there are significant emissions and ongoing policy discussions, such as the legislation in Washington State, despite the absence of a federal farm tax. These high-income examples were selected for data availability and because their farming interests and emissions profiles have parallels with India's (e.g., populous farm sectors, strong political influence of agriculture).

Literature Review: Global Discourse on Methane Pricing

There is active debate in the literature on whether and how to price methane from agriculture. Proponents argue that taxing methane (or more broadly pricing agricultural emissions) is an application of carbon pricing to an often-neglected sector, internalizing the climate costs of livestock and rice production (Parry *et al.*, 2022). They cite the short climate lifetime of CH_4 (≈12 years) as a unique opportunity: reductions yield near-term climate benefits and cleaner air. Global initiatives reflect this: for example, at COP26, over 100 countries (but *not* India) joined the U.S.-EU Global Methane Pledge to cut CH_4 by 30% by 2030 (Rabe, Kaliban and Englehart, 2020).

By contrast, critics note that food demand (especially for staples like milk and meat) is relatively price-inelastic. Several studies estimate low demand elasticities (e.g., ~0.75 for beef, ~0.59 for milk), implying a methane tax would largely burden farmers rather than cut consumption. Equity concerns arise as well: farmers fear being made to "pay for the largesse of others", and low-income consumers could face higher food prices (Metcalf, 2021). These arguments have led many experts to favour incentives and innovation over blunt taxes. The IPCC, UNEP, and national studies generally emphasize technological fixes (feed additives, vaccines, genetics) and management practices (diet changes, biogas capture, rice irrigation methods) rather than immediate taxes (Ammal, 2024). For example, New Zealand's *Pastoral Greenhouse Gas Research Consortium* (PGGRC) works on cutting sheep and cow emissions without resorting to taxation. U.S. policy discussions similarly emphasize research funding and voluntary measures, such as the proposed EMIT LESS Act to subsidize farming techniques that reduce methane, rather than imposing levies (Thakur and Solanki, 2022).

Political economy is critical. In most countries, farmers are highly organized, and food security is paramount. Any suggestion of a "fart tax" has provoked outcry. The literature notes that proposals often face backlash, so effective policy likely requires farmer partnership. For instance, New Zealand's *He Waka Eke Noa* initiative was designed as a co-developed pricing scheme. Similarly, the EU briefly considered an agricultural emissions trading system, but dropped explicit targets in 2023 after farmer protests. In sum, academic and policy analysis acknowledge methane pricing as a theoretically sound "polluter pays" tool, but emphasize political feasibility and complementary measures (Zech and Schneider, 2019). Several reviews stress that any pricing in agriculture must be fair, targeted (e.g., only on large operations), and revenue-recycling (e.g., funding farmer support or climate R&D). This nuanced view guides the real-world experiments that the paper now examine.

International Comparative Analysis

New Zealand: "Fart Tax" Proposals and Partnerships

New Zealand is unusual in having frequently grappled with farming methane. About 48–50% of NZ's greenhouse gas emissions come from agriculture (mostly livestock CH_4). As far back as 2003, the government proposed an Agricultural Emissions Research Levy: a modest tax (≈NZ$8.4 million/year) on livestock farms to fund methane research. Dubbed the "fart tax" by opponents, it triggered large farmer protests (National Party MP Shane Ardern famously drove a tractor to Parliament) and was withdrawn when farmers agreed to partially self-fund the research instead. The experience left lasting political wariness toward Pigouvian levies (Metcalf, 2009). on farmers. More recently, New Zealand attempted a cooperative approach. The Zero Carbon Act (2019) set targets to cut CH_4 by 10% below 2017 levels by 2030 (and 24–47% by 2050), and mandated that agriculture find a pricing mechanism. The government and farming industry formed the *He Waka Eke Noa* partnership to design a farm-level emissions pricing scheme. The partnership's 2021 recommendation was a "split-gas levy": separate charges for *biogenic methane* and *long-lived gases* (CO_2/N_2O), reflecting methane's different impact (Hooks and Stewart, 2011). On this basis, NZ's 2022 Emissions Reduction Plan committed to pricing agricultural emissions by 2025. Under the proposal, farmers above certain size/fertilizer thresholds would pay based on herd emissions, with part of the revenues going to R&D and tree planting offsets. (For example, the 2021 plan announced farmers would pay from 2025, with funds to support farm research and climate tools.) Political changes have disrupted this design. In June 2024, New Zealand's new coalition government dropped agriculture from the ETS and disbanded He Waka Eke Noa. It stated climate goals remain, "without shutting down farms," but set no specific methane levy schedule. Thus, as of 2025, New Zealand *has not implemented* a methane tax – its earlier plans have stalled, illustrating the challenge of farmer buy-in. The 2022 NZ plan did establish a $4.5 billion "Climate Emergency Response Fund" from ETS revenues to support measures, but this is general climate finance, not a methane tax *per se* (Hooks and Stewart, 2011).

European Union (with Denmark's "Flatulence Tax")

The European Union treats agriculture differently. The EU's Effort Sharing Regulation (for 2021–30) sets national targets that implicitly include farming emissions, but does not impose an EU-wide price on farm methane. Instead, agriculture must cut emissions through regulations and incentives (Sørensen *et al*., 2025). The Common Agricultural Policy (CAP) provides "eco-schemes" and conditional payments for certain environmentally-friendly practices, but no direct GHG levy. Methane is addressed in EU policy mainly via research and best practices. Agriculture contributes about 12% of total EU GHG (380 Mt CO_2e in 2022), with roughly two-thirds of that from livestock (enteric fermentation and manure) (Sørensen *et al*., 2025). Non-CO_2 gases (CH_4 and N_2O) are the bulk, specifically enteric CH_4 (49%) and N_2O from soils (30%). Notably, EU agricultural emissions have been stubbornly flat: only ~5% below 2005 levels by 2022 (Thomsen, Raza and Byrialsen, 2025). Projections suggest that without extra action, reductions by 2030 will be only ~4–7% under planned measures, highlighting the difficulty of deep cuts without new policy tools. Within the EU, a few countries have

discussed or taken stronger steps. The most striking case is Denmark, which in late 2024 agreed on a national "flatulence tax." As part of its Green Tripartite climate deal, Danish farmers will pay a levy of DKK 300 (≈US$43) per tonne of CH_4 (in CO_2-equivalent) starting in 2030, rising to DKK 750 by 2035. This is explicitly billed as the world's first livestock emissions tax (Hu, Meo and Islam, 2025). The plan is paired with large land-use changes: converting significant farmland to forests and restoring peatlands for CO_2 sequestration (Brahim, Wiese and Münster, 2019). Denmark expects the tax and accompanying reforms to transform 250,000 ha into forest and restore 140,000 ha of peat, aiming to cut overall emissions and improve biodiversity. (About 60% of Denmark's land is arable, so this is a major shift.) Outside Denmark, no EU nation has imposed a methane fee on farms. Earlier discussions (e.g., a proposed EU Agricultural Emissions Trading System) have not been enacted (Thomsen, Raza and Byrialsen, 2025). In fact, in 2023, the European Commission reportedly dropped planned agriculture emission reduction targets to placate farmers. Thus, the EU approach remains: rely on efficiency measures, technology, and afforestation, rather than uniform taxes (Hu, Meo and Islam, 2025).

United States

In the United States, agricultural methane has similarly been left largely untaxed. The Inflation Reduction Act (2022) does introduce a federal methane fee, but *only* for the oil and gas sector. This "waste emissions charge" starts at $900 per ton of CH_4 in 2024 (around $36/t$CO_2$e) and rises to $1,500 by 2026, and will apply to facilities emitting over a threshold. Importantly, livestock and agricultural activities are explicitly excluded; only about 29% of U.S. methane sources (mostly fossil fuel production) are covered (Fam and Fam, 2024).

On the agricultural side, no federal CH_4 tax or fee exists. Instead, U.S. policy focuses on research and voluntary measures (Bistline *et al*., 2022). For example, in mid-2024, legislators introduced the bipartisan EMIT LESS Act to help farmers adopt methane-reducing practices (better feeding regimes, silage, methane inhibitors). The USDA also invests in dairy digesters, nitrification inhibitors (for fertilizer), and other mitigation R&D. Some states are experimenting: Washington state's 2024 bill (HB 1630) would require large dairies and feedlots to report their annual methane emissions (Chen and Hafstead, 2019). If farms emit above the state's "major emitter" threshold (25,000 t CO_2e/yr), they would be treated as covered entities under the state cap-and-trade, effectively subjecting them to carbon pricing. Similar state-level initiatives are rare (Salas and Dunn, 2024). In summary, the U.S. approach has been non-punitive toward farmers; there is no broad carbon pricing on agriculture, but rather only targeted research grants and voluntary actions (Fam and Fam, 2024). This reflects strong political resistance in farm states. (By contrast, U.S. federal policy on methane generally targets oil/gas leaks and landfills, not farms. For example, Biden's Methane Action Plan allocates billions to plug abandoned wells and fund municipal waste reductions.) Recent political changes may further weaken prospects (Salas and Dunn, 2024). On January 20, 2025, the newly inaugurated second Trump administration formally announced U.S. withdrawal from the Paris Agreement. This retreat from global climate leadership likely undermines incentives for any new domestic CH_4 regulation or pricing, as the national emphasis shifts away from ambitious emission controls.

Other Notable Approaches

Beyond NZ, the EU, and the U.S., a few other jurisdictions merit mention. In Canada and Australia, agricultural emissions are part of national GHG inventories but are not currently taxed; instead, governments offer incentives (e.g., Canada funds manure digesters and forage research) (Thamo *et al*., 2019; Windfeld and Lhermie, 2022). Developing countries have been largely absent from methane-tax debates, focusing more on renewable energy and adaptation. One high-profile case was Argentina, which at COP27 (2022) announced a voluntary goal to cut livestock CH_4 by 33% by 2030 (through better feeds) – essentially a pledge rather than a tax. China and Russia, while top CH_4 emitters, have prioritized energy-sector methane and have not targeted agriculture as aggressively (Nordin *et al*., 2024).

India's Agricultural Emissions and Policies

India has the world's largest cattle herd (≈303 million bovines) and is the largest global milk producer. Its agriculture accounts for roughly 14% of national GHG emissions (excluding land use change) (Ammal, 2024). Livestock and rice together drive India's methane output. In 2016, India reported about 409 million tonnes CO_2-eq of methane, with ~74% from agriculture (livestock and rice). India is also the world's third-largest methane emitter overall. Thus, methane is a non-negligible part of India's climate footprint (Kalita and Barua, 2019).

Unlike some countries, India has no carbon or methane tax on agriculture. Indian climate strategy has so far prioritized energy and forestry. The National Action Plan on Climate Change and successive Five-Year Plans emphasize renewable energy, efficiency, and adaptation. However, recognizing methane's dual role in climate and pollution, India has incorporated some agri-mitigation measures (Singh *et al*., 2017). In 2023, the Environment Ministry issued "*Measures to Reduce Methane Emissions*," which highlights existing programs: the National Mission on Sustainable Agriculture (NMSA) promotes climate-smart rice cultivation; the National Livestock Mission (NLM) supports breed improvement and better feeding; and schemes encourage fodder production, silage, and mixed rations. The Gobar Dhan program also subsidizes biogas from cow dung, turning CH_4 from waste into energy. These initiatives aim to reduce methane passively, but India's NDC (Nationally Determined Contribution) does *not* assign a specific target for agricultural emissions, nor did India join the COP26 Global Methane Pledge (Valiyeva and Garashli, 2025).

India faces particular hurdles if it were to consider a methane tax. Over half the rural population depends on agriculture for income, mostly in small-holdings (Gayatri and Jose, 2014). Livestock are integral to rural livelihoods and food security. Imposing levies could be seen as threatening incomes or raising food prices. The fact that methane comes largely from buffalo (highly valued for milk) and rice (staple crop) makes the sector sensitive. Moreover, technical data on emissions is sparse, complicating any per-farm charge. Indian officials have often referred to livestock methane as "a fact of life", indicating political reluctance to penalize farmers. Instead, India tends to focus on co-benefits: for example, reducing stubble burning cuts both carbon and local air pollution; solar pumps under PM-KUSUM reduce diesel use (cutting CO_2 and black carbon). The

Climate Action Tracker notes India's emphasis on adaptation and efficiency (solar irrigation, fertilizer management) rather than aggressive agri-mitigation (Martinez-Vazquez and Zahir, 2023).

In short, India's agricultural methane is large, but current policy treats it within broader climate and development plans. No farmer pays a carbon or methane levy today. Instead, mitigation efforts rely on extending best practices (improved rice varieties, animal husbandry) (Kumari *et al*., 2019). The major obstacles – social, economic, and informational – mean any direct tax is politically untenable under current conditions.

The Methane Maze: Global Experiments, Political Roadblocks, and India's Policy Puzzle

Several governments have modeled the impacts of farm-level methane pricing. In New Zealand, official analysis (Ministries' 2024 report) found that a farm-level CH_4/N_2O levy could meet NZ's 2030 methane target. That modelling estimated: even a low CH_4 price (~NZ$2.86/t CO_2e) would achieve ≥10% CH_4 reduction (target) by 2030, primarily by reducing stocking rates and adopting mitigations. The same analysis found the levy would generate substantial revenue: enough to pay for mitigation incentives and leave a NZ$100–140 million surpluses annually (Hooks and Stewart, 2011). The surplus would cover the program's setup ($87M) and running costs ($32M/yr). This suggests the fiscal viability of a methane levy in NZ, provided politically. In Denmark, formal cost modeling has not been published publicly yet, but officials expect the levy to drive land-use change (e.g., 10% farm-to-forest conversions) and encourage innovation. The broad agreement also includes funds (via increased carbon pricing revenue) for paying farmers to retire ecologically sensitive land (Sørensen *et al*., 2025).

For the US, while no domestic CH_4 tax exists on livestock, independent analysts note that methane pricing (like the IRA's oil/gas fee) would raise sizable sums ($1–3 billion/year) (Metcalf, 2019). Moreover, USDA studies (e.g., economic appraisals of feed additives) show high internal rates of return for methane inhibitors. EU modelling (for context) indicates that paying farmers to adopt feed additives or low-emission diets could be cost-effective given the social benefit (Zolkover *et al.,* 2024). For example, a UK economic analysis found that a 30% enteric-methane reduction additive could produce net positive welfare even without a tax. (Noted these studies qualitatively; they are consistent with observed moves towards voluntary funds and subsidies rather than punitive taxes.) Imposing a methane tax or levy in India faces steep challenges. Agriculture employs almost 50% of India's population, contributes ~15–20% of GDP, and uses culturally sensitive livestock (cows are sacred to many). Rural livelihoods are fragile: any per-animal tax would be highly regressive and politically explosive. Indeed, at COP26, India's negotiators specifically rejected a global methane pledge over "fears for farming and trade". Constitutional and trade constraints also loom: India's climate commitments avoid binding farm clauses, emphasizing income and food security protections (Gill and Ramachandran, 2021).

Legally, no Indian statute or policy currently mandates pricing livestock methane. National climate laws (e.g., the Energy Conservation Act or the Environmental Protection Act) have no agricultural emission charges (Chateau *et al*., 2023). There have been no recent legislative bills to tax farm CH_4. In Parliament, the government has

repeatedly highlighted sectoral programmes instead of taxes: the National Mission for Sustainable Agriculture (NAPCC) promotes rice techniques (SRI, direct seeding) to cut methanogenesis, and the National Livestock Mission funds breed improvement and balanced feeding to lower enteric emissions. Similarly, schemes like GobarDhan incentivize biogas digesters and bio-manure from cow dung, effectively reducing manure methane (Panagariya, 2010). These point-based incentives fit India's approach: "carrots" for mitigation rather than "sticks" (Chateau *et al.*, 2023). Small landholdings dominate Indian farming; monitoring each animal's emissions would be technically daunting. Fuel prices and input taxes (fertilizer, petrol) do raise GHG costs indirectly, but farmers often circumvent them via subsidies or by growing more crops to compensate (Goldberg *et al*., 2025). A direct methane levy would likely be passed entirely onto farmers (or drive cattle underground). Politically, Indian farmers are a powerful lobby (as seen in recent protests), so any punitive agri-charge would be untenable. In sum, India's current policy stance – reflected in NDCs and national programs – is to eschew an agri methane tax and instead promote mitigation through practice changes and renewable energy (biogas).

Findings

As of 2025, no country has fully implemented a comprehensive methane tax specifically targeting farmers. While the idea has circulated in policy circles for decades, most experiments have either been abandoned or remain in their infancy. New Zealand, often considered a pioneer in agricultural climate policy, attempted a methane levy as early as 2003, but fierce backlash from farmers led to its withdrawal. Even more recent reforms in the 2020s have struggled to gain traction. The European Union, though progressive on climate in many respects, still lacks a unified methane pricing mechanism. Denmark stands out as a rare exception, having agreed to a methane levy in late 2024but even this policy is scheduled to take effect only from 2030. Meanwhile, countries like the United States and India have largely focused on subsidies and voluntary programs, avoiding binding taxation mechanisms altogether. As a result, little empirical data has been collected on whether methane taxes can deliver meaningful emission reductions in agriculture (Ostapenko *et al*., 2024).

One reason for the limited implementation is the significant political resistance such policies provoke. Across jurisdictions, proposed methane taxes have met with stiff opposition, especially from farming communities. In New Zealand, the 2003 levy was infamously dubbed a "fart tax" and scrapped under pressure. Similar resistance has emerged in the European Union, where farmer protests have blocked the enforcement of more ambitious climate targets. Even in countries that acknowledge the need for agricultural climate action, such as Denmark, the only viable path forward has been consensus-building and compromise. Denmark's methane levy was crafted in partnership with farmer groups, not imposed unilaterally. The delay until 2030 signals a broader lesson: that climate accountability in agriculture cannot be coerced; it must be co-designed with those who work the land) (Opalchuk *et al*., 2024).

Because taxation remains rare, actual reductions in agricultural methane emissions have been minimal. In the EU, agricultural emissions are projected to fall by only 5–7% between 2005 and 2030 under current policies, a modest change considering the urgency

of climate targets. In New Zealand, farm-related emissions have continued to rise, partially offset only by forestry carbon credits. Even the recently introduced methane fee in the United States, aimed at fossil fuel producers, does not address the vast majority of agricultural methane. The global trend is clear: current approaches are not delivering significant emission cuts in the farming sector, and future progress will depend on new and better-designed policies (Scoones, 2023).

Many countries have chosen to support technological innovation and encourage voluntary mitigation instead of relying on direct taxes (Salsabilla and Agung, 2024). For example, in New Zealand, the Pastoral Greenhouse Gas Research Consortium has investigated changes in animal feed and breeding techniques to reduce methane emissions. Similarly, Sweden has financed research on additives that can decrease methane production, while the European Union has invested in enhancing rice cultivation practices. Denmark's climate plan emphasizes changes in land use, while India has recently launched initiatives under the National Mission on Sustainable Agriculture and the Livestock Mission to promote better livestock management and rice farming techniques. These programs, while slower in showing results, offer co-benefits such as biogas energy production, healthier soils, and improved farm incomes that taxes alone might not.

Another major barrier to implementing methane taxes lies in measurement and equity (Howarth, 2015). Estimating farm-level methane emissions is inherently complex. Factors like animal species, diet, geography, and seasonal patterns all influence emissions, making it difficult to apply a uniform tax rate. Washington State in the U.S., for example, has proposed that farms first report emissions as a preparatory step before any pricing is introduced. Beyond measurement, fairness is a critical concern. Flat methane taxes risk being regressive, hitting smallholders the hardest. Farmers have raised valid questions: how can one price fit all when herd efficiency, land productivity, and access to mitigation tools vary so widely? Without carefully designed exemptions, support schemes, and revenue recycling mechanisms, such taxes could inadvertently deepen rural distress rather than drive sustainable transformation.

In essence, methane taxation in agriculture remains more of a theoretical aspiration than a global reality. Yet the mere fact that countries are beginning to consider it seriously. Denmark going so far as to legislate a future levy signals a turning point. Climate policy can no longer afford to overlook agriculture, and methane, as a potent greenhouse gas, must be addressed. The path forward will not be easy, but the lessons are increasingly clear: future policies must be participatory, equitable, and paired with investment in technology and adaptation. Only then can methane pricing evolve from a political flashpoint into a workable solution for climate accountability in farming.

Recommendations for India

To effectively reduce agricultural methane emissions, India must take a comprehensive and inclusive approach rooted in its existing frameworks while paving the way for innovation and collaboration. A key step forward is scaling up climate-smart agricultural practices already identified by government missions. For instance, rice cultivation, a major source of methane, can benefit greatly from promoting alternate wetting and

drying irrigation, direct-seeded rice, and mid-season drainage under the National Mission on Sustainable Agriculture (Rajamani, 2009). Similarly, livestock-related emissions can be reduced by strengthening the National Livestock Mission through wider adoption of better-quality feed, green fodder, silage, and improved breeds. These interventions, which are already being piloted, have the potential to cut emissions per animal by 10–15% by boosting digestive efficiency and overall productivity. Extension networks like Krishi Vigyan Kendras should be actively used to spread awareness and provide farmer training, as outlined in the July 2023 measures.

At the same time, India needs to invest more in research and development of low-emission agricultural technologies. Institutions like ICAR and CSIR can lead efforts to create and trial feed additives such as red seaweed or 3-nitrooxy compounds that reduce enteric methane. Similarly, better manure digesters and methane-reducing rice farming methods, like introducing methanotrophic bacteria into soils, can significantly help. Public-private partnerships, especially with dairy cooperatives, can fast-track trials of such innovations. Lessons can be drawn from successful international models, like New Zealand's PGGRC, where government-industry collaboration has driven cutting-edge emissions science. Funding for this R&D could come from carbon markets or international climate finance.

Biogas production and agricultural waste management offer another important avenue. The Gobar Dhan and Bio-CNG initiatives, if backed with stronger subsidies and infrastructure support, can enable dairy farmers to convert cow dung and crop residues into clean energy, thus reducing methane and creating economic opportunities. Tackling stubble burning through strict enforcement and by promoting the use of machines like Happy Seeders would further reduce emissions and improve rural air quality. These interventions not only benefit the climate but also enhance rural incomes and livelihoods.

For large-scale operations, a gradual move towards emissions transparency can lay the groundwork for more ambitious climate actions (Reay, Smith and van Amstel, 2010). India could begin by requiring major dairy and feedlot farms to measure and disclose their methane emissions. Initially, this would serve as a data-gathering exercise rather than a punitive tax, allowing stakeholders to understand their impact and build capacity. Over time, this could evolve into a targeted pricing mechanism, such as a small levy on the highest emitters, with the funds reinvested into rural development or agricultural innovation. Carbon finance and offset markets also hold promise (Reay *et al.,* 2018). Farmers could be incentivized to adopt emission-reducing practices like planting trees on degraded lands, restoring wetlands, or switching to low-methane feeds, and in return, earn carbon credits. India's evolving carbon market can create space for such agriculture-based offsets, aligning with global models where farmers are financially rewarded for sustainable practices. Any future methane tax should be revenue-neutral, with the proceeds channeled back into agriculture to support such transitions.

Equally crucial is farmer engagement. Policies must be shaped with the active involvement of the farming community, following participatory models like New Zealand's He Waka Eke Noa. A multi-stakeholder platform involving government, scientists, and farmer organizations can co-design region-specific pilot projects and fine-tune incentive structures. Outreach efforts should communicate the additional benefits,

like improved yields or income from biogas, to build trust and participation. Finally, India must not isolate itself from the global methane agenda. Although it has not joined the COP26 Global Methane Pledge, the country can still collaborate with international partners through initiatives like the U.S.-India Global Methane Pledge partnership. Sharing technology, funding, and best practices through global research consortia can help India leapfrog to climate-smart farming with reduced costs and better results.

Overall, the comparative experience suggests that incentives and innovation work better than immediate levies in India's context. This paper does not recommend an immediate "methane tax." Instead, by expanding existing climate-agriculture programs, investing in mitigation tech, and gradually bringing large farms into reporting/cap systems, India can begin to bend the curve of agricultural emissions. Over time, as cleaner farming methods lower the national emissions baseline, policymakers may reconsider targeted pricing on any remaining high emitters, ensuring the transition is fair and productive.

Conclusion

Methane taxes and agricultural levies remain a cutting-edge and contentious climate tool. The international overview shows no simple model. Success stories have instead come from combining policies, research funding, subsidies, and regulations to slowly transform agricultural practices (Andrew, 2008). Key lessons for any country are to respect the sector's sensitivities, engage farmers as partners, and use revenues to support and not to punish the transition. Taxing methane is generally seen as a way to reduce emissions, but there are a number of obstacles that make it impractical and ineffective, especially in nations with a high reliance on agriculture (Herbeda *et al*., 2025). One of the most significant challenges is the economic burden on farmers. Methane taxes could lower farm profitability, especially for small and medium-sized farmers, by raising production costs. Such financial strains may result in farm closures and fewer rural job opportunities in nations like India and Ireland, where farming communities primarily depend on livestock for their income (OECD, 2023; Tol *et al*., 2008). The inflationary impact on food prices is another issue. Meat and dairy products may become more expensive if livestock methane emissions are taxed, which would disproportionately impact consumers with lower incomes. This could make already-existing socioeconomic disparities worse in developing countries where food affordability is already a significant problem (World Bank, 2023). The problem of carbon leakage is another. Agricultural companies may move to nations with less stringent regulations if methane taxes raise production costs in one nation, shifting emissions rather than lowering them (IPCC, 2023). This risk highlights the need for coordinated global policies rather than isolated taxation measures. For India, the mandate is clear but challenging: agricultural emissions are large, but any climate policy must protect small farmers and food security (Blitzer *et al*., 1992). A tailored mix of policies, such as scaling up best practices, funding innovation, incentivizing clean methods, and only cautiously exploring pricing for major emitters, offers a practical path forward. Learning from New Zealand's experiments, Denmark's deal, and U.S. incentives, India can craft its approach that balances climate goals with rural development. A good substitute for taxes is funding for studies and farmer education on sustainable breeding methods.

Also, Methane can be captured and turned into energy rather than escaping into the atmosphere. In addition to lowering emissions, biogas plants can turn methane from manure into renewable energy, giving farmers another source of income (FAO, 2023). The infrastructure for biogas can be funded by governments, and farmers can be encouraged to take part in these initiatives. Governments can create voluntary methane reduction programs in collaboration with agricultural stakeholders in place of enforcing mandatory taxes. Nations such as the U. S. used this strategy, providing farmers who voluntarily adopt methane-reducing practices with financial incentives and technical assistance (EPA, 2023). This guarantees that farmers are encouraged to embrace sustainable practices in a way that benefits them financially rather than being coerced into expensive compliance. Ultimately, reducing methane from India's farms will contribute significantly to both national targets and global climate mitigation, but it must be done judiciously.

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Authors' Declarations and Essential Ethical Compliances

Author's Contributions (in accordance with ICMJE criteria for authorship)

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